Biomechanical parameters of start technique and starting acceleration in smooth and hurdling sprint in men

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Abstract

Objective of the study was to compare the spatial characteristics of the start technique and starting acceleration in 60 m and 60 m hurdles in men at the stage of higher sportsmanship.

Methods and structure of the study. The main method was the analysis of biomechanical parameters of motor action technique. For this, data from the IAAF biomechanical report of the men's final races in the 60 m and 60 m hurdles at the 2018 World Indoor Athletics Championships were used [3, 4].

Results and conclusions. In men running 60 m and 60 m hurdles in the starting blocks in the body position on the "attention" command, the analysis of spatial characteristics revealed significantly significant differences in the angle between the torso and thigh of the front leg ($p \leq 0.05$). In the exit phase from the blocks, the greatest differences are observed in the angles of extension of the knee joints and the inclination of the lower leg of the fly leg ($p \leq 0.05$). At the first three steps of the starting acceleration for hurdlers, all the studied angles have large average values. These results confirm the need to take into account the differences in the start technique and starting acceleration in smooth and barrier sprints when developing special training tools and exercises.

Keywords: *sprint running, hurdling, sprint start and starting acceleration technique, 60 m run, 60 m hurdles run, spatial characteristics of running, biomechanical parameters of sprint running.*

Introduction. In sprinting, one of the key phases is the start and starting acceleration, and the shorter the distance, the greater their significance. The adoption of the optimal position in the starting blocks and effective actions during the acceleration steps have a direct impact on the acceleration and further running along the distance. In sprinting with hurdles, the starting acceleration is additionally influenced by the distance to the first hurdle, the number of steps taken, for men it is seven or eight. The study and comparison of the technique of leading runners at these distances allows obtaining data that can be used in the selection and development of means and methods of technical, special physical training.

Objective of the study was to compare the spatial characteristics of the start technique and starting acceleration in 60 m and 60 m hurdles in men at the stage of higher sportsmanship.

Methods and structure of the study. For our research we used the datas from Biomechanical reports for the IAAF World Championships 2018 [5,6]. In 60 metres were analyzed eight athletes, in 60 metres hurdles - seven athletes, all the finalist of their events. Statistical data analysis was determind by program Statgraphics Centurion, the significant off different was determined by Independent Samples T-test.

In research we analyzed spatial (angular) characteristics of the athletes body position in starting blocks in "set position", during the clearance phase at the point of block exit and first three steps. In the Figure 1 there are body schematic denoting angles: trunk angle (α), knee angle of the front leg (β,) knee angle of the rear leg (β'), the angle between the trunk and the front thigh (γ), the angle between the trunk and the rear thigh (γ'), the angle between thighs (γ'-γ), the angle between rear shin and horizontal line (θ'), ankle angles at block exit (⌊ and ⌊').

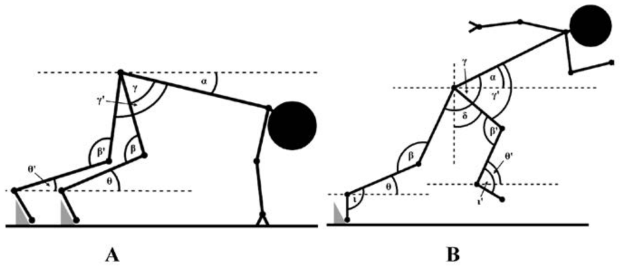

Figure 1. *Body schematic angles at set position (A) and block exit (B)*

Results of the study and their discussion. In starting blocks in set position (Table 1) the statistically significant difference (p≤0,05) between sprinters and hurdlers are observed only in the angle between the trunk and the front thigh (γ), 45,3±2,4˚ and 35,0±2,8˚, respectively. Smaller value of this angle in hurdling can be explained by setting the blocks closer to the start line for reducing the distance to the first hurdle and accomplishing seven-steps approach in acceleration. All researched hurdlers used such acceleration that is typically for most elite athletes. Average values of trunk angle (α) in both groups are similar and equal to 17˚, however, hurdlers have greater spread of data, 9˚ to 25˚. Similar situation are observed in the front knee angle (β). On average, for all athletes, it is equal to 90˚, but range of values is from 70˚ to 100˚. In 60 metres hurdles rear knee (β') is bent less, than on 60 metres, 110,7± 7,4˚ and 120,9± 3,2˚, respectively (p >0,05).

In both distances the knee extension (β) at the moment of block exit is less then 180˚ (Table 2). The lowest value for both distances is 157˚, the highest is in hurdling - 179˚, in 60 m - 166˚. In hurdling there are observed greater values in trunk angles (α) 41,0± 2,8˚ and 36,2± 1,6˚, respectively, (p>0,05), shin angle in the front block (θ), 30,2±2,2˚ and 24,1±1,2˚, respectively, (p≤0,05), knee angle in the swing angle (β'), 72,0± 2,4˚ and 60,3±3,2˚, respectively, (p≤0,05), swing thigh angle (δ) 59,8±1,6˚ and 55,7±3,5˚, respectively, (p>0,05), hip angle (γ), 174,1±1,6˚ and 170,7±1,2˚, (p>0,05). This provides more rapid body extension in the start acceleration and necessary position for hurdle take-off. At block exit all studied athletes have ankle dorsiflexion in swing leg, angle ⌊' is almost 90˚, rear ankle (⌊) has 130-140˚.

The differences that athletes have during the block exit effect on the body position during the acceleration phase. At touchdown and takeoff on the hurdler's first three steps like at block exit there are observed less trunk (α) and shine (θ') incline, (p≤0,05), higher value of knee angle (β) and hip angle (γ). Swing thigh in hurdling acceleration flex more than in 60 metres (p≤0,05).

Conclusions. As a result of the conducted research it was revealed that elite sprinters and hurdlers have similar average values of the body's spatial characteristics in the set position in blocks. However, hurdlers have more spread of values to most variables, what is caused by the individual rhythm and tempo characteristics of the start acceleration. At block exit in 60 metres hurdling all researched angular parameters

Table 1. Spatial characteristics in starting blocks at set position for men's 60 m and 60 m hurdling (in degrees)

Race	Meaning	Result	α	β	β'	γ	γ'	γ'-γ	θ	θ'
60m (n=8)	$\bar{x} \pm S_{\bar{x}}$	6,51± 0,03	17,5± 1,4	92,8±1,8	120,9± 3,2	45,3± 2,4	80,1±3,1	34,7±2,3	30,8± 1,8	22,2± 0,7
	σ	0,09	4,0	5,1	9,1	6,7	8,9	6,4	5,2	2,1
60 mH (n=7)	$\bar{x} \pm S_{\bar{x}}$	7,60± 0,04	17,2± 2,0	89,9±3,2	110,7± 7,4	35,0± 2,8	73,6±6,3	38,5±7,8	35,8± 1,6	24,7± 2,4
	σ	0,12	5,3	9,7	19,7	7,5	16,8	20,6	4,3	6,5
p			>0,05	>0,05	>0,05	≤0,05	>0,05	>0,05	>0,05	>0,05

Table 2. Spatial characteristics at block exit of elite men in 60 metres and 60 metres hurdling (in degrees)

Race	Meaning	Result	α	β	β'	γ	γ'	γ'-γ	θ	θ'	δ	⌊	⌊'
60m (n=8)	$\bar{x} \pm S_{\bar{x}}$	6,51± 0,03	36,2± 1,6	162,0± 1,0	60,3± 3,2	170,7± 1,2	71,5± 4,41	99,2± 4,3	24,1± 1,2	26,1± 5,5	55,7± 3,5	136,4± 2,0	89,3± 3,5
	σ	0,09	4,5	2,9	9,1	3,3	2,4	12,1	3,3	15,6	9,9	5,7	10,0
60 mH (n=7)	$\bar{x} \pm S_{\bar{x}}$	7,60± 0,04	41,0± 2,8	169,0± 2,9	72,0± 2,4	174,1± 1,6	80,8± 7,0	93,2± 6,8	30,2± 2,2	43,2± 3,5	59,8± 1,6	137,7± 3,9	86,7± 1,1
	σ	0,12	7,5	7,6	6,5	4,3	18,6	18,0	5,8	9,2	4,4	10,3	2,8
p			>0,05	≤0,05	≤0,05	>0,05	>0,05	>0,05	≤0,05	≤0,05	>0,05	>0,05	>0,05

have larger average values. There are statistically significant differences in knee angles and shank angles ($p \leq 0,05$). The similar tendency is observed on the first three steps of acceleration. These features must be considered in preparation sprinters with different specializations in selection and designing exercises that similar by spatio-kinematic characteristics to event.

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